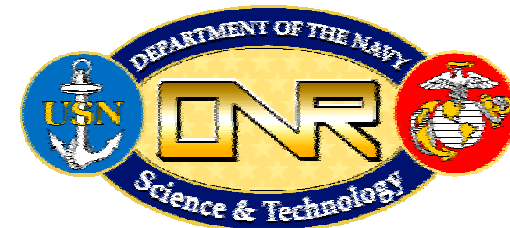


Electrospark Deposited Coating Technology for Naval Applications

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OBJECTIVE AND APPROACH

Objective

- Produce good quality coatings using electrospark deposition (ESD)

Approach

- Identify Navy components for repair
- Develop ESD processing parameters
- Assess ESD coating quality

NAVY NEEDS

- Total ownership cost reduction
 - *Increase maintenance efficiency*
 - *Extend component service life*
- Increased readiness
 - *Reduce maintenance turn around times*
- Reduced environmental impact
 - *HAZMAT reduction*

ESD SYSTEM



ESD SYSTEM



POTENTIAL APPLICATIONS



Steering and Diving Control Rod



Steering and Diving Control Rod



Rubber Insulated Sound Isolation Coupling



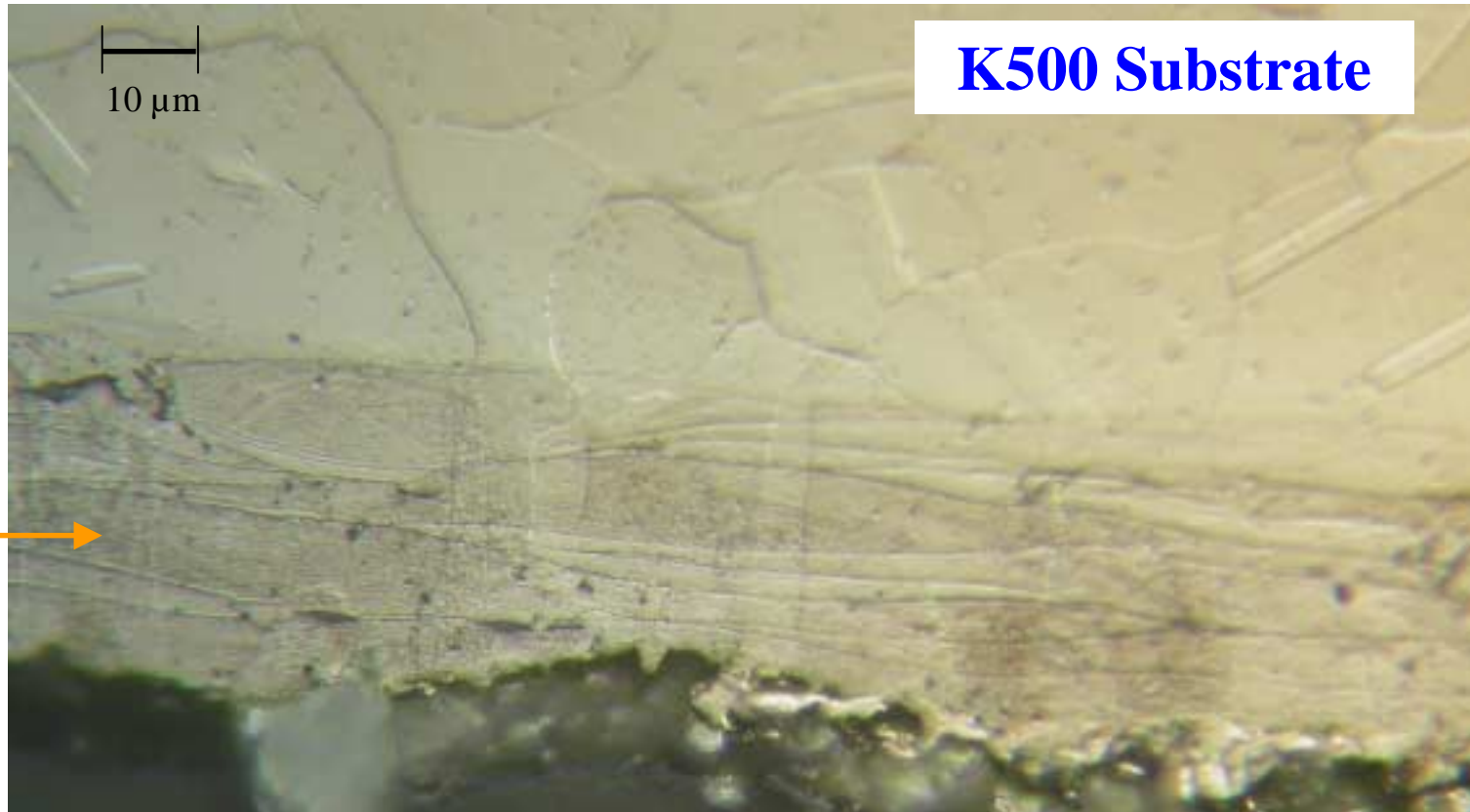
Hull Valve Stem



ESD COATINGS

- Alloy 400 (Ni-Cu)
- 70/30 Cu-Ni
- Ni-Cr-Mo Alloys
 - *Alloy 625*
 - *Alloy 59*
 - *Alloy C276*

ESD Alloy 400 on K500



K500 Substrate

**ESD Alloy
400**

ESD Alloy 400 on K500

ESD Coating :

Alloy 400

Hardness (VHN)

127

224

183

193

216

200

**Alloy 400 Hot Finished
Rod and Bar:**

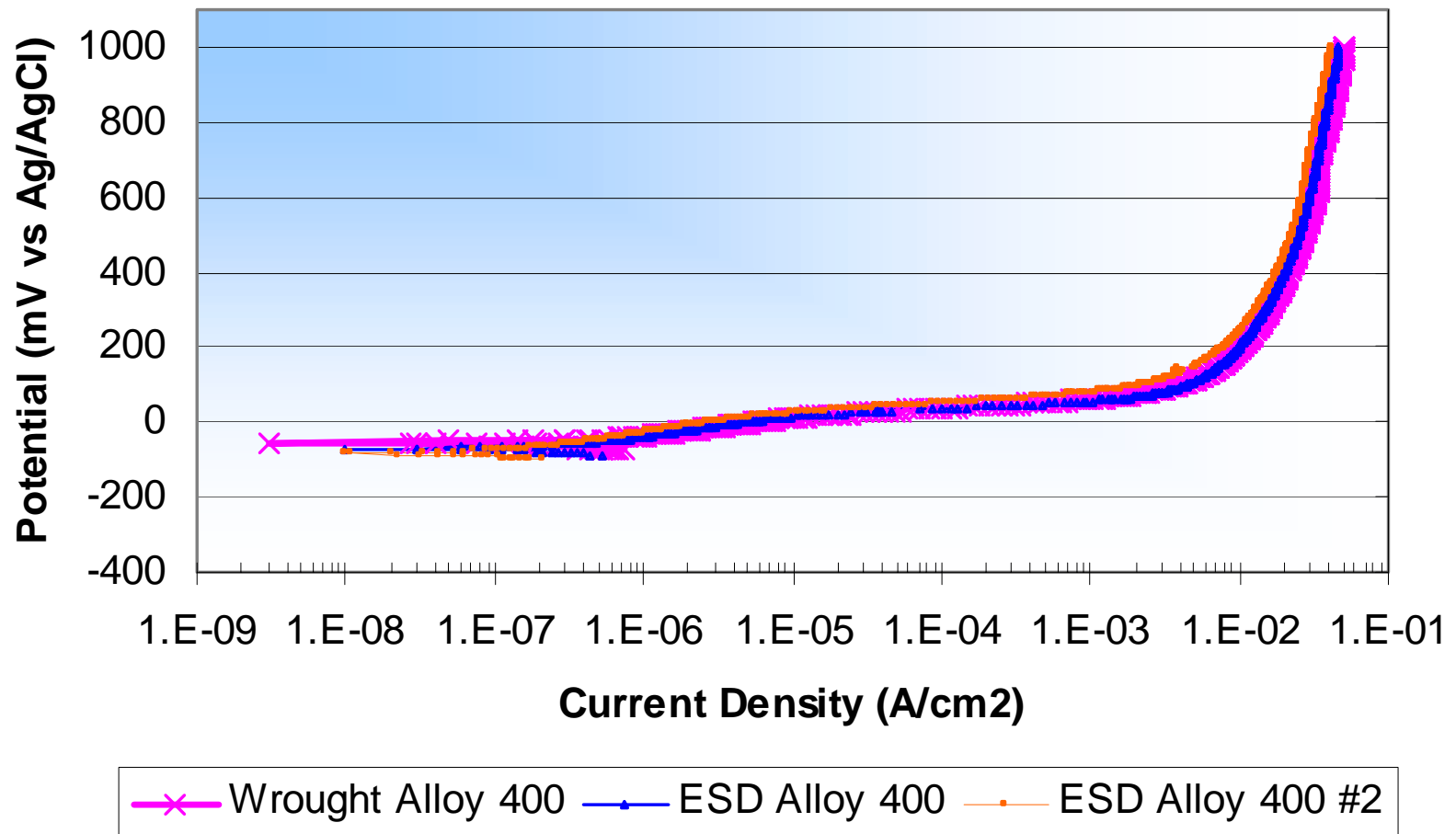
VHN 140-250

ESD Alloy 400 on K500

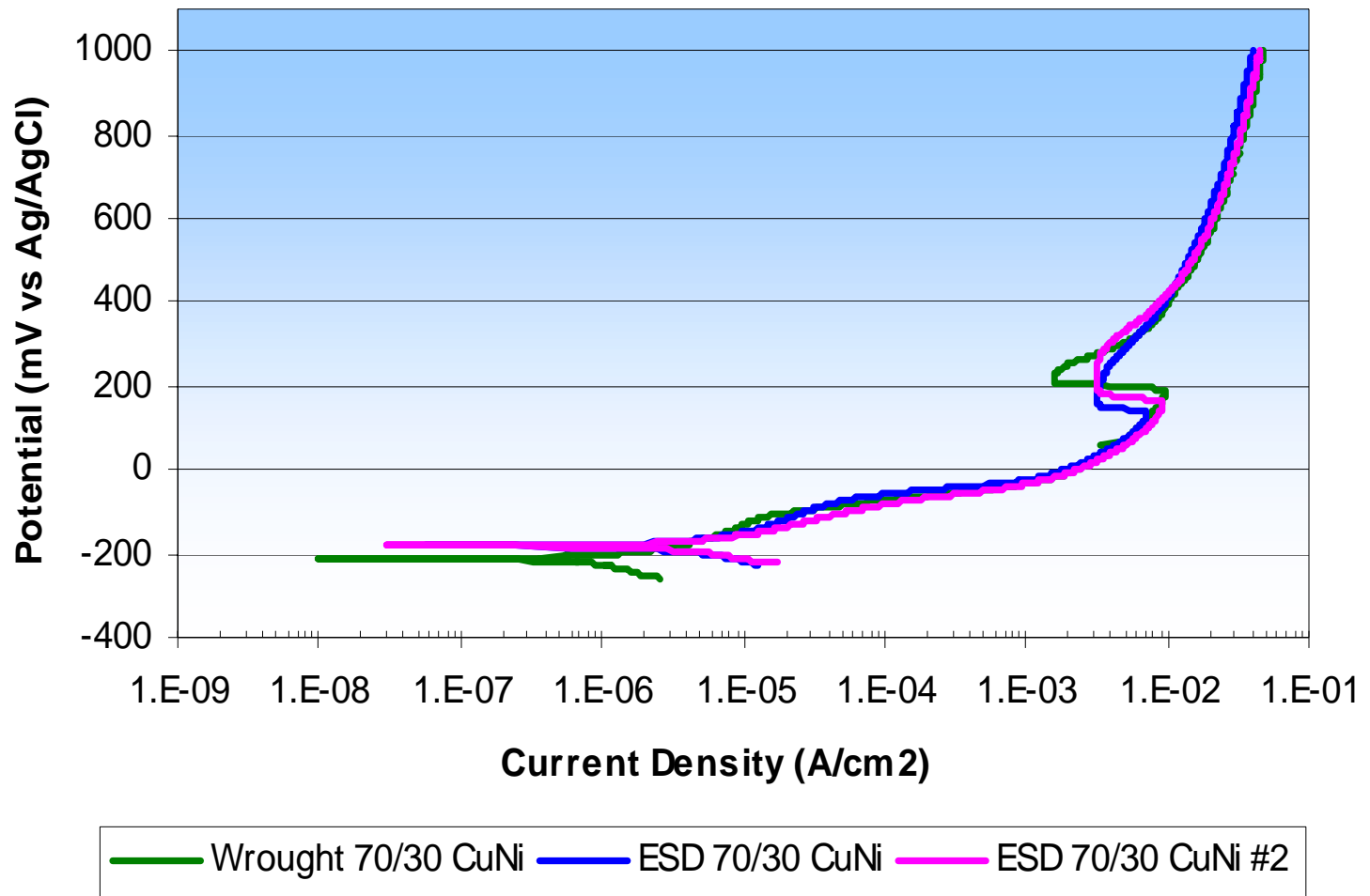
**K500 Hot Finished
& Aged Bar:
280-370 VHN**

Alloy K500 Hardness (VHN)	Depth from Coating/Substrate Interface (um)
335	20
332	500
359	1000
338	1500
332	2000
338	2500

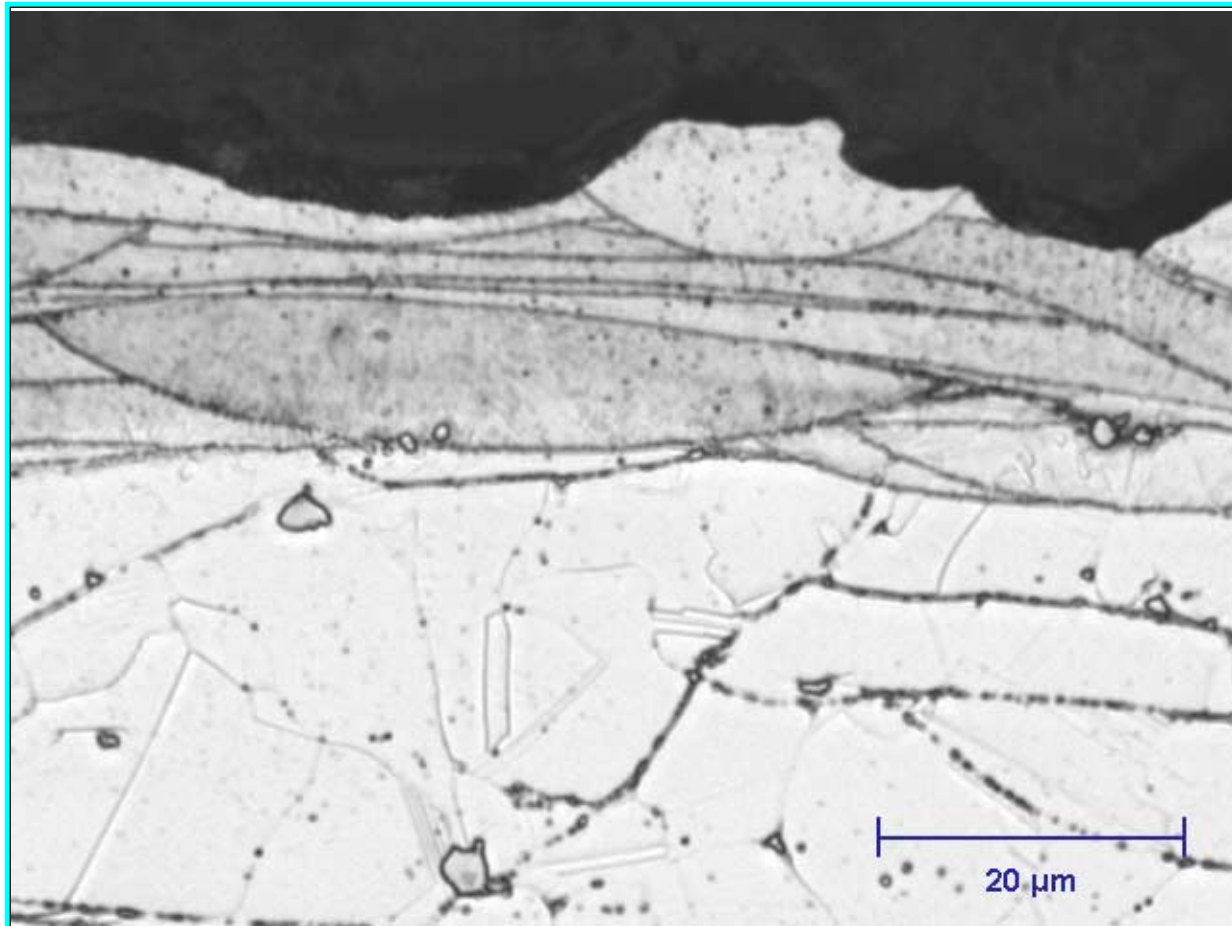
ESD Alloy 400 on K500



ESD 70/30 Cu-Ni on 70/30 Cu-Ni

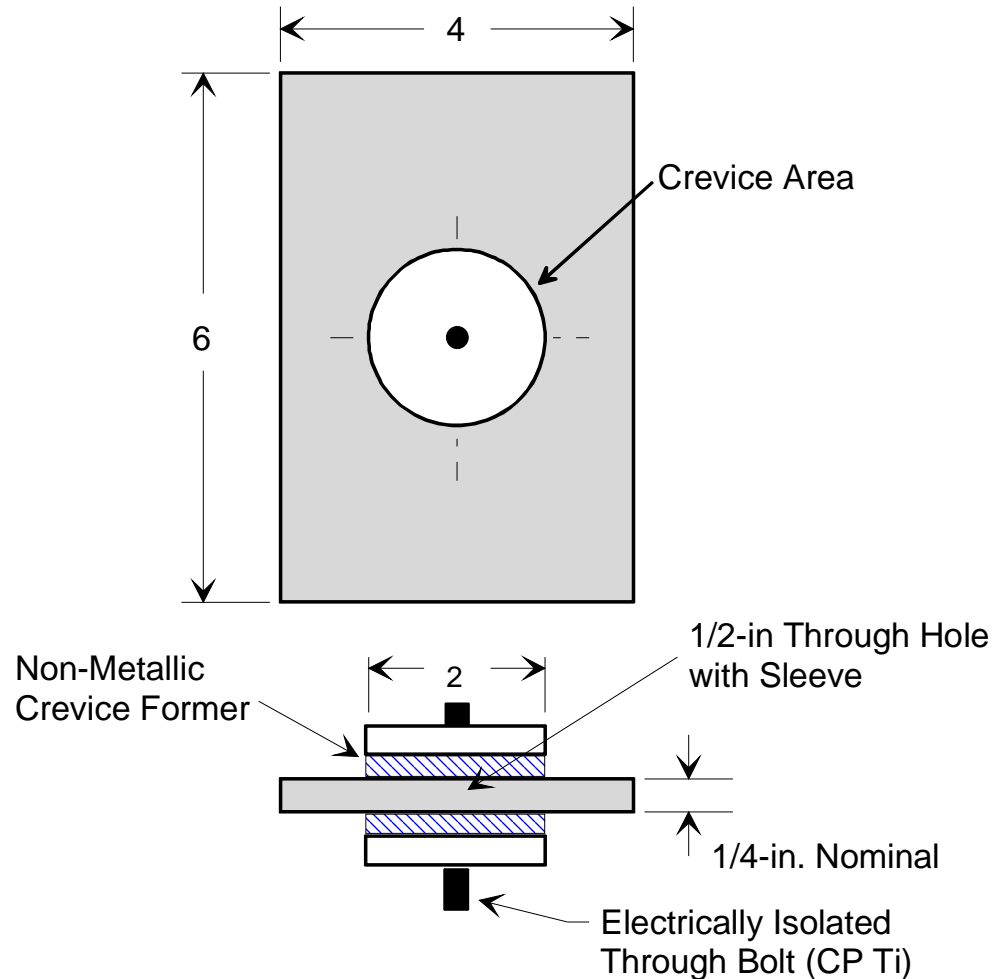


ESD Alloy 625 Coating



ESD of Ni-Cr-Mo Alloys on Alloy 625

Crevice Corrosion Testing in Natural Seawater



ESD of Ni-Cr-Mo Alloys on Alloy 625

Crevice Corrosion Testing in Natural Seawater



Ni-Cr-Mo Alloy Crevice Tests: 183 Days

<i>Material</i>	<i># of Initiated Sites</i>	<i>Time to Initiation (days)</i>	<i>Max Depth of Attack (mm)</i>
Wrought 625	3	98, 161(2)	0.51
Wrought C276	0	----	0
Wrought 59	0	----	0
ESD 625	0	----	0
ESD C276	0	----	0
ESD 59	0	----	0

Ni-Cr-Mo Alloy Crevice Tests: 365 Days

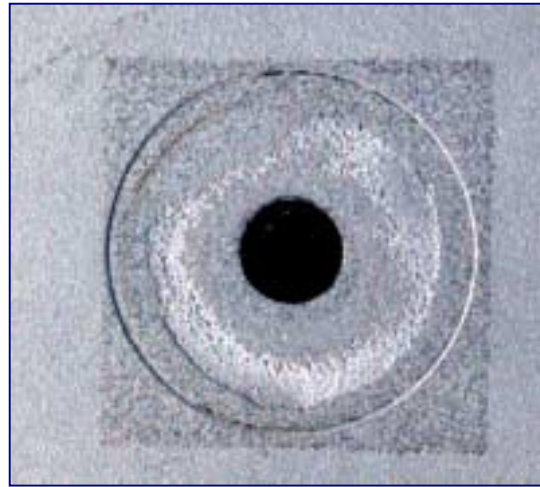
<i>Material</i>	<i># of Initiated Sites</i>	<i>Time to Initiation (days)</i>	<i>Max Depth of Attack (mm)</i>
Wrought 625	1	162	0.25
Wrought C276	0	---	0
Wrought 59	0	---	0
ESD 625	2	315(2)	0.28
ESD C276	3	280,315(2)	0.22
ESD 59	0	---	0

Ni-Cr-Mo Alloy Crevice Tests: 365 Days



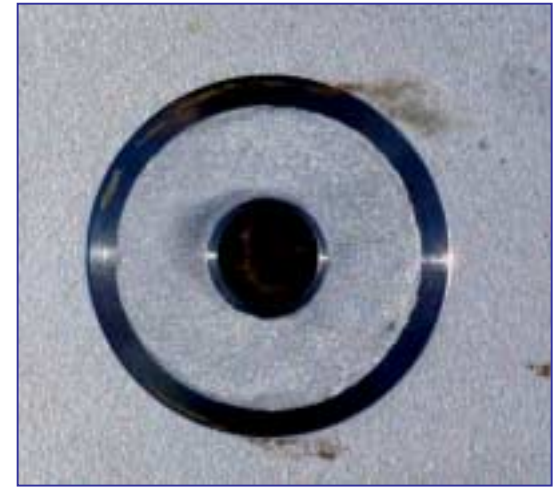
ESD Alloy 625

*Max. Depth of
Attack = 0.008 in*



ESD Alloy C276

*Max. Depth of
Attack = 0.009 in.*



*Wrought Alloy 625
Control*

*Max. Depth of
Attack = 0.010 in.*

SUMMARY OF RESULTS

- ESD Coatings of Alloy 400, 70/30 CuNi, and Alloys 625, C276, and 59 Applied Using ESD
- Microhardness Evaluation of ESD Alloy 400 on K500
 - *ESD coating hardness similar to wrought Alloy 400*
 - *No thermal distortion of K500 substrate*

SUMMARY OF RESULTS

- Potentiodynamic Polarization Testing of ESD Alloy 400 and 70/30 CuNi
 - *Similar anodic polarization behavior between ESD coating and wrought counterpart*

SUMMARY OF RESULTS

- Crevice Corrosion Evaluation of ESD Ni-Cr-Mo Alloys
 - ESD Alloy 59: *No crevice corrosion initiation after 365 days, similar to wrought 59*
 - ESD Alloy 625: *Improved crevice corrosion resistance as compared to wrought 625*
 - ESD Alloy C276: *Increased crevice corrosion susceptibility as compared to wrought C276 (resistant after 365 days)*